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Andy Lin

Anthony Chou

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Abstract

With its pioneering role in Taiwan and the enormous global popularity of ETFs, it is imperative to conduct a broad examination of the TTT, Taiwan's first ETF. Building upon previous studies, this research attempts to investigate: (1) the characteristics and formation of tracking errors of the TTT, (2) the underlying factors which influence the premium/discount of the TTT, and (3) the pricing factors of the TTT's return and trading volume. Interesting conclusions are reached. First, the tracking error of the TTT is mainly constituted by its cash dividends, whose impact became so obvious in the peak dividend payout season. Second, the management expenses are identified as the main factor causing the gap between two different tracking error series. Third, the effect on TTT tracking errors of stock replacement operations is documented. It is evident that there are three apparent shocks, signaling potential arbitrage opportunities. Nevertheless, this arbitrage potential is deemed limited and the duration is short. Finally, the multivariate model shows that the TTT discount/premium could be attributed to its own volatility and market return. And the return of the TTT is highly correlated with the general stock market movements and its arbitrary opportunity. However, the trading volume of the TTT is merely affected by its own price volatility.

Key words: exchange traded fund, tracking error, TTT discount/premium, volatility, net asset value

Andy Lin, Ph.D., U-C Professor of Finance, Faculty of Management, Malaspina University-College
Anthony Chou, Malaspina University-College, Canada

Introduction

To meet global development trends, capital competition and challenges, the Taiwan Stock Exchange Corporation has expanded the market scope and breadth for financial securities since Taiwan entered the WTO. After considering the operational difficulties involved with derivatives and the overwhelming investing ratio of retail investors, exchange traded funds (ETFs) became the official objective. Thus, the Taiwan Stock Exchange Corporation chose Polaris Investment Trust to be the partner corporation and introduced the first Taiwan ETF, the Polaris Taiwan Top 50 Tracker Fund (TTT), to the market on June 30, 2003. After the TTT was formally introduced, the development of relevant exchange traded products strode forward, such as Taiwan futures, financial futures and electrical futures; even the Taiwan 50 index was launched at the same time. All of these made Taiwan's indexation investment process more diversified.

The concept of ETFs stemmed from the growth of index-linked investment products in the 1970s (Wiandt & McClatchy, 2002) and the first successful ETF, Standard & Poor's 500 Depositary Receipts (SPDRs), was introduced on the American Stock Exchange in 1993 (Jares & Lavin, 2004). Within twelve years, the scale of global ETFs has increased from US$800 million dollars in 1993 to US$ 314.9 billion dollars at the end of March 2005. Global ETF issues also soared to 362; even China has issued a "Shanghai 50 A Index", while a "Shanghai 180 A Index" will be launched in the same stock market in the near future. According to Morgan Stanley Research, at the end of March 2005, the United States, the largest ETFs market in the world, launched 164 ETFs, and the size of ETFs increased dramatically. In terms of asset size, the United States represents 73.4% of the global ETF market, followed by Europe's 11.7% and Japan's 8.4%. As the only ETF in Taiwan, the TTT's asset scale is ranked 7th in the world, ahead of Korea, Australia, and China (TTT, 2005).

In the first three months of TTT trading, the number of stock baskets increased from 116 to 654 where one basket is equal to one million shares. During the same period, the average daily turnover of the TTT was 6,916 lots (1 lot =1,000 shares) and the turnover rate was 5.6% (Lin & Meng, 2004). In addition, the total TTT assets soared from NT$4.3 billion at its IPO at the end of June 2003 to NT$ 46.52 billion and 1.0025 billion shares on June 30, 2005. The fact that the TTT only consists of 50 Taiwanese stocks does not decrease the importance of the index, as the TTT reflects the essence of the market, accounting for 70% of the total market capitalization, with a correlation coefficient of 98.9% to the weighted stock price index (TTT, 2004). In addition, these 50 individual stocks are not permanent; the stock exchange will adjust the composition standard quarterly to better trace the market. The TTT's NAV is estimated and disclosed by the Taiwan Stock Exchange Corporation (TSEC) every 15 seconds with the daily price fluctuation set at 7% during trading hours.

Given the TTT's brief history and the rapid increase of ETF investment popularity, this research intends to investigate the fundamental characteristics of Taiwan's first ETF. Contrary to Lin and Meng (2004), who emphasized the efficiency of the TTT's formation, this study's primary focuses are tracking error, premium/discount, and pricing factors. The tracking error will be diagnosed thoroughly and decomposed to reveal its underlying structure. As well, the determinants of pricing and premium/discount will be examined. It is expected that the results of this study will have valuable implications for current and future investors and will certainly provide some insights into the future development of this type of financial product.

The rest of this paper is divided into four parts. First of all, after the introduction, the development history and characteristics of ETFs, including the TTT, will be briefly presented and the relevant literature will be highlighted and reviewed. Secondly, a quantitative method will be applied to examine how attractive Taiwan's first ETF is to market participants. The model proposed by Elton, Gruber, Comer and Li (2002) will be employed to examine the TTT's return and pricing factors. The third section reports the data set and empirical results. Finally, based on the findings, some practical implications regarding ETF's will be suggested. Overall, by scrutinizing the formation of characteristics, tracking error, premium/discount, and pricing factors of the TTT's returns and volume, the performance and appeal of the TTT will be unveiled.

Background and Literature

Characteristics of ETFs

The main characteristic of an ETF is to be a benchmark index which can be tracked (Gastineau, 2001). Since the shareholding ratio of an ETF will be the same as the ratio of the benchmark index constituent, investors buy an ETF just as they invest their money in common funds. In addition, ETFs are index funds that trade just like stocks on major stock exchanges and help investors focus on what is most important of the choice of asset classes (Venkatesh, 2002). Although ETFs are a relatively new investment tool, they have caught on quickly through many top names in the investment industry such as Dow Jones, Merrill Lynch, iShare, and Standard and Poor's, who have prompted a frenzy of further innovations.

Another important feature of ETFs, which differs from other financial vehicles, is passive management. The passive management of ETFs pursues the "duplication" of the index as a primary objective in order to keep the price and index in the same relative movement (TTT, 2005). ETF Investors may apply for creation/redemption via a participating dealer to the manager. Here, 'creation' refers to investors delivering a portfolio of stocks in exchange for ETF units and 'redemption' refers to investors converting ETF units into a portfolio of stocks. Since ETFs imitate the performance of

the index and track the relative movement between the NAV and the index, applying the concept of passive management, the only way to adjust the portfolio is to change the constituents and weights of the index composition.

It is important to understand that the ETF's pricing is subject to supply and demand of the issued shares in the market. While the price of the ETF occurs as a premium or a discount to the NAV of the portfolio, this difference may be arbitraged (Blau, 2004). Hence, based on the characteristic of creation and redemption, this unique so-called "in-kind" mechanism can eliminate the gap between the net asset value and the market price of ETFs (TTT, 2005).

Generally speaking, an ETF is a hybrid of stocks and open-end funds. ETFs offer several benefits: positive tax implications, trading flexibility, continuous pricing, lower costs, and minimal trading fees. Firstly, since ETFs are passively managed portfolios, they generally realize fewer capital gains than actively managed funds. Secondly, ETFs do offer trading flexibility such as the ability to trade shares during the middle of a volatile trading day, issue a limit or stop-loss order, and trade at short or on margin. A wide variety of ETFs also exists, such as fixed income, industry sector and international diversification. This considerable breadth of ETF alternatives provides investors with the ability to invest in indexes that were previously unavailable to them (Lin & Meng, 2004). Thirdly, continuous pricing allows traders to buy and sell throughout the trading day, not just at the closing price of the day. Fourthly, due to reduced marketing, distribution and accounting expenses and the passive nature of index investing, expenses are extremely low as compared with many traditional mutual funds (Nuveen Investments, 2001). And finally, since ETFs are purchased and sold like regular stocks, only brokerage fees are paid to purchase or sell units.

Taiwan's First ETF (TTT)

ETFs have prevailed overseas for more than ten years. The earliest ETF market in Asia is the Tracker Fund of Hong Kong, which was launched in November 1999 (Yip, 2002). Following Hong Kong, Japan, Singapore and South Korea, Taiwan is the fifth ETF issuance market in Asia. As the weighted index of Taiwan is a collective index of all companies listed in the market, the index includes stocks whose circulation could be challenging. As a result, this index may not accurately reflect the economic performance of Taiwan. In order to better reflect the main fluctuations of the market and to ensure that there is no interference by stocks with insufficient transaction volume or by constituent stocks without sufficient representation, 50 stocks are chosen from the electronic, finance, plastic, transportation and other well-known industries. This compilation fully portrays the fluctuations of Taiwan's economy. In addition, the total market value of these 50 constituent stocks is close to 70% of the total market capitalization of the weighted index.

The Taiwan 50 index is constructed in the following fashion (TTT, 2005):

$$\sum_{i=1}^{50}\left(\frac{p_i \times s_i \times f_i}{d}\right)\times 5000 \qquad \text{i=1,2,3,……,50}$$

where,

p = price: latest trading price of the constituent stock.

s = number of issued stock: based on the issue volume of individual stock utilized by FTSE.

f = free float coefficient: announced by FTSE. This is used to adjust the coefficient of the weight of each stock and the coefficient is expressed by a value between 0 and 100 percentage points.

d = divisor: represents the market value of the fund future index constituent stock issue number after adjustment of the free float volume. The divisor can be adjusted so as to ensure an un-twisted index when replacement changes or other regulatory impacts occur, and the continuity of the index can be maintained.

Periodical examination of component stocks will be conducted on Thursday after the first Friday of January, April, July and October. If there is a change in constituent stocks, then the replacement will be executed on the next trading day following the third Friday in that month. However, in order to avoid frequent changes in constituent stocks, a replacement will only be conducted when the capitalization ranking of a target stock rises above 40 or drops below 60 in the market.

The TTT has some unique features. First, being highly representative of the entire market value and with a correlation coefficient as high as 98.9%, the Taiwan 50 index can fully depict the movement of the overall stock market in Taiwan. Second, with respect to the compilation of the index, the Taiwan Stock Exchange is authoritative and has the credibility to ensure market acceptance. By combining this with the techniques and experience of the internationally reputed index compilation company, FSTE, the Taiwan 50 index concurrently possesses professional superiority locally and internationally. Third, the industry distribution of the Taiwan 50 index is appropriate. The percentage occupied by the electronics industry is higher, conforming more to the present development trend of Taiwan's economy. And lastly, the Taiwan 50 index has a clear-cut constituent stock change examination timetable. In this way, investors can clearly understand the operational procedures of the committee and investors will have a high degree of confidence in the index.

Tracking Error

Tracking error can be separated into two categories, price-to-index tracking error and the NAV tracking error (Hill & Mueller, 2001). Price-to-index tracking error is based on a certain trading time of an ETF, and the level of deviation between market return and target index return is the scheme of measurement. As this tracking error comes from market value, this category of tracking error can reflect the demand and supply conditions of the market.[1] However, this definition has so far been less adopted in literature. The measurement of the NAV tracking error, more widely accepted, is defined as the difference in return between the target index and the NAV. It can be utilized to measure whether an ETF is the best method to track accurately the target index in the long run. Owing to the special trading system of the ETF's in-kind mechanism and the consideration of the ETF commodity design structure, this research is of the belief that the NAV tracking error is more appropriate.

Elton et al. (2002) studied SPDRs from February 1993 to December 1998 and concluded that cash dividend and management expenses are the two primary interference variables of tracking error. When tracking error includes the dividend reinvestment and deduction of management expenses, the NAV return is lower than the S&P index return by 28 basis points. However, Blume and Edelen (2004), by studying S&P500 index funds, argued that the tracking error was minimal and the index had been tracked quite closely. Harper, Madura and Schnusenberg (2001) also found that iShare had no significant tracking error during their study period.

Premium/Discount

The TTT's redemption system may trigger arbitrage trading when there is a substantial difference between the market price and the NAV. Theoretically, the level of premium/discount of the ETF is not supposed to be substantial provided that the arbitrage in-kind mechanism exists. Focusing on SPDRs, Elton et al. (2002) also showed that on average the SDRs had been traded on 1.8 bps discount. In addition, on about 70% of trading business days, the range of discount/premium phenomenon was not more than US$1/8. Furthermore, it was discovered that the discount/premium phenomenon will not continue for more than one trading day. It was eliminated quickly by market demand and supply or by arbitragers. On the other hand, Ackert and Tian (2000) targeted SPDRs and found that dividends and capital gains were the major determinants of discount/premium.

[1] In addition, it also includes the mobility caused by short-term market noise and risk evasion trading. Other factors like the ETF market, constituent stocks and futures will have an effect on demand and supply in the market (Pope & Yadav, 1994).

In general, the discount/premium condition for global ETFs does not yield a uniform conclusion and the length of either discount or premium trading is still inconclusive. Various factors, including trading habits, market characteristics and legal standards, may all play a role.

Trading Volume/Return

Elton et al. (2002) further reported that within the period of February 1993 to December 1998, when there was active participation in the short-term trading of SPDRs, the market trading volume was extremely large. About 10% of the daily shares circulating outside were traded in 1998. Short-term traders utilized SPDRs to conduct risk evasion on market risk and when the market price deviation from the NAV was substantial, these traders could earn a spread. Therefore, it can be summed up that generally the trading volume is likely to be affected by market volatility and/or arbitrage opportunity.

Methodology

Building upon previous studies, this research attempts to investigate: (1) the characteristics and formation of the tracking errors of the TTT, (2) the underlying factors which influence the premium/discount of the TTT, and (3) the pricing factors of the TTT's return and trading volume. The following sections detail the steps and approaches employed to achieve the above goals.

Tracking Error

In reality, although no indexing strategy can perfectly match the performance of an index or benchmark, the tracking error can quantify the degree to which the strategy differed from the index or benchmark (Chatterjee et al., 1997). There are two tracking error series compiled in this study. The first tracking error series follows the conventional definition of:

$$\text{NAV tracking error} = \text{TENRIR} = R_{NAV} - R_{TWFI}$$

Where R_{NAV} = return based on the NAV of TTT[2]

R_{TWFI} = return of Taiwan 50 Index[3]

[2] The NAV of the TTT per share is equal to the total market value of the securities that substantiate the TTT plus a value that is equal to the accumulated cash dividends on the underlying shares minus accumulated management and license fees (Lin & Meng, 2004).

TENRIR is the tracking error series accounting for management fees, stock replacement impact as well as cash dividend accumulation. The primary variable is the NAV which takes into account all internal and external effects. As well, the cash dividend reinvestment is incorporated in the NAV.[4]

The second tracking error series has the following definition:

Reward tracking error = TERRIR = R_{TWFR} - R_{TWFI}

where TERRIR= reward tracking error

R_{TWFR} = return based on the return index of TTT[5]

This tracking error shows a different picture of the tracking error composition. TERRIR, based on the return index of the TTT, without deduction of management fees and with adjustments to balance price drops due to dividend payouts, will show a greater accumulation value than TENRIR over time. The "reward" is used here to denote the pure hypothesized reward assuming that there are no management expenses and no stock replacements and the negative impact on the price of dividend payouts of underlying shares is also removed. This series reflects the exclusive impact from dividend receipts and payouts.

The conventional two-sample t test is applied first to investigate the mean equality of TENRIR and TERRIR. Hence, the null hypothesis is set to be $H_0 : \mu_{TENRIR} = \mu_{TERRIR}$. Then, the Levene's test (Levene, 1960) for equal variances is also applied for the following null: $H_0 : \sigma^2_{TENRIR} = \sigma^2_{TERRIR}$. A support to both nulls will suggest an insignificant contribution of management fees and stock replacements to the magnitude of the tracking error.

As proposed by Elton et al. (2002), the major contributor to tracking error is dividend payouts to the TTT. To investigate the impact of dividends, this paper starts with an assumption that TENRIR is a likeness of TERRIR.

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[3] The Taiwan 50 index is weighted by market capitalization of underlying shares, only stock dividends are considered and cash dividends are not included in the index. In addition, the impact of price fluctuations of component stocks caused by their dividend payouts is not adjusted for (TSEC, 2005).

[4] Note that a time lag exists between the time of receiving dividends and the time when the new shares are purchased from the market to create new ETF units. This time lag may have an impact on trading errors, but the impact is not deemed to be substantial.

[5] Since the Taiwan 50 return index adjusts its advisor when its underlying stocks pay out dividends, the return index will not be negatively impacted by the dividend payouts (TSEC, 2005).

$$TENRIR_t = \alpha + \beta * TERRIR_t + \varepsilon_t$$

From a statistical point of view, the influence level of dividend payouts and receipts will be identified with a significant β, and the ε_t should comply with all properties. Following this specification, the estimated values of β signal how dividends contribute to the formation of tracking errors.

Stock substitution is another aspect that may affect the level of tracking errors. In the following regression model, non-numeric variables will be allowed to reflect this effect. To this end, dummy variables whose categorical values identify stock replacements over the studied period will be employed in this investigation. Given the fact that there are seven portfolio readjustments during the studied period, seven dummy variables will be implemented. As a result, the new equation is given as:

$$TENRIR_t = \alpha + \beta_0 TERRIR_t + \beta_1 D_{1,t} + \beta_2 D_{2,t} + \beta_3 D_{3,t} + \beta_4 D_{4,t} + \beta_5 D_{5,t} + \beta_6 D_{6,t} + \beta_7 D_{7,t} + \varepsilon_t$$

The above regression equation will be further scrutinized by the stepwise regression method which will refine the process and provide the most optimal model from these potential variables.

Premium/Discount, Return Trading Volume

Premium/discount has long been of interest to researchers and market participants. One main stream is to investigate the influential factors of premium/discount. To accomplish this goal, the proposition of Elton et al. (2002) is selected. The premium/discount is estimated by a direct differencing between the daily closing price and the NAV. The run test will be applied first to verify the randomness of the premium/discount series. If the result of the run test doesn't support randomness, then a multivariate model will be utilized to inspect the impacts of relevant variables.

Following the proposition of Elton et al. (2002), an ETF's return is closely related to general stock movements and characteristics such as market volatility and market arbitrage opportunity. As a result, these market variables as well as the TTT's own characteristics will be formulated together to detect the determinants of the TTT's premium/discount and return and trading volume. These variables' definitions are stipulated below.

TTT Price Volatility

The price volatility of the TTT is defined as the highest price minus the lowest price divided by the closing price. If swings over a short time period are observed, the TTT is categorized as a high volatility portfolio in the market. This variable is calculated with the following formula:

$$\left[\frac{TTTH_t - TTTL_t}{TTTC_t}\right]$$

where $TTTH_t$, $TTTL_t$, and $TTTC_t$ represent the highest, lowest, and closing prices on day t of the TTT.

TTT Arbitrage Opportunity

The difference between the closing price and the NAV is used to proxy the arbitrage opportunity (Shleifer & Vishny, 1997). For example, when the TTT is traded at a discount to its net asset value, institutional investors could assemble thousands of units in the open market at the discounted price, redeem them for the underlying stocks, and sell those stocks to reap a profit. Therefore, when the absolute value of the difference between the price and the NAV is high, speculative trading will be induced (Elton et al., 2002). This effect will take place on the following trading day; as a result, a one day lag is identified in the specification.

$$\left[\left|\frac{TTTC_{t-1} - NAV_{t-1}}{NAV_{t-1}}\right|\right]$$

Market Volatility

The definition of this variable is similar to that of TTT price volatility except that the TSEC index replaces the TTT.

$$\left[\frac{TWIH_t - TWIL_t}{TWIC_t}\right]$$

where $TWIH_t$: the highest index value at day t

$TWIL_t$: the lowest index value at day t

$TWIC_t$: the closing index value at day t

Market Arbitrage Opportunity

Since the TTT's components are the top 50 market capitalizations of TSEC and each constituent stock is the leader of its specific industry, the TTT's fundamentals are expected to be highly correlated with the TSEC's characteristics. The following variable, market arbitrage opportunity, is also included in the investigation.

$$\left[\left|\frac{TWIC_t - TWIC_{t-1}}{TWIC_{t-1}}\right|\right]$$

where $TWIC_t$ is the closing index value at day t.

Based on the above specifications, the following model is explored:

TTT's premium/discount

$$= DPNRTR_t = \alpha + \gamma_1\left[\frac{TTTH_t - TTTL_t}{TTTC_t}\right] + \gamma_2\left[\left|\frac{TTTC_{t-1} - NAV_{t-1}}{NAV_{t-1}}\right|\right] + \gamma_3\left[\frac{TWIH_t - TWIL_t}{TWIC_t}\right] + \gamma_4\left[\left|\frac{TWIC_t - TWIC_{t-1}}{TWIC_{t-1}}\right|\right] + \varepsilon_t$$

Theoretically, a high degree of price and volatility changes in the market should have a significant effect on the amount of trading. Thus, if the t-statistics of some variables are significant, these variables could be used as a risk control or arbitrage strategy tool.

The above examination is further applied to the TTT's return and trading volume series. This examination will unveil the relationships between the TTT's return and trading volume and their potential pricing factors. As a result, the following equation is specified:

TTT's daily return or trading volume

$$= \alpha + \delta_1\left[\frac{TTTH_t - TTTL_t}{TTTC_t}\right] + \delta_2\left[\left|\frac{TTTC_{t-1} - NAV_{t-1}}{NAV_{t-1}}\right|\right] + \delta_3\left[\frac{TWIH_t - TWIL_t}{TWIC_t}\right] + \delta_4\left[\left|\frac{TWIC_t - TWIC_{t-1}}{TWIC_{t-1}}\right|\right] + \varepsilon_t$$

Empirical Results

Data

The research data set of this study comes from the websites featuring the Polaris Taiwan Top 50 Tracker Fund, the Taiwan Stock Exchange Corporation, and the Taiwan Ebid. The NAV of the TTT is from Polaris International Securities Investment Trust which has subtracted routinely the relevant expenses, such as custodian fees, management fees, and index license fees. The sample period extends from June 30, 2003, the first listing day of the TTT, to March 10, 2005, with a total of 423 daily observations.[6] The TTT's constituent list is adjusted quarterly on the next business day of the third Friday in January, April, July, and October, in reflecting new developments in the stock market. Seven adjustments were done on the constituent list during the sample period. Table 1 provides descriptive statistics of the variables included.

Table 1: Descriptive Statistics of Included Variables

Variable	Total Count	Mean	SE Mean	TrMean	StDev	Minimum	Median	Maximum	Skewness	Kurtosis
TWFI	423	4478.2	13.5	4475	277.9	3672.3	4471.2	5216.3	0.1	-0.01
TWFR	423	4671.8	14	4675.7	287.8	3731.5	4678.5	5383.1	-0.31	0.12
TTTNA	423	45.902	0.136	45.933	2.806	36.8	45.99	52.91	-0.27	0.09
TTTV	423	6580	218	6119	4481	783	5538	31243	1.9	5.15
TTTD	423	303425	10388	280047	213657	35973	250370	1466450	2.03	5.68
TTTO	423	45.909	0.136	45.942	2.801	37.09	46.02	53.5	-0.29	0.24
TTTH	423	46.198	0.135	46.219	2.768	37.4	46.27	53.7	-0.23	0.28
TTTL	423	45.578	0.137	45.617	2.817	36.92	45.75	52.55	-0.31	0.1
TTTC	423	45.887	0.136	45.917	2.792	37.08	45.95	53.15	-0.27	0.16
TTTN	423	694	18	657.5	370.1	161	618	2514	1.81	4.6
TWIO	423	5931.6	19.4	5919.2	399.7	4881	5901	7106	0.52	0.39
TWIH	423	5967.9	19.3	5954.9	397.9	4900	5924	7135	0.56	0.44
TWIL	423	5886	19.2	5874.3	394.7	4864	5854	6963	0.49	0.31
TWIC	423	5924.3	19.2	5912.1	395.3	4872	5886	7034	0.51	0.34
TWIV	423	91806	2001	89015	41163	372	84301	253697	1.13	1.71
NAVR	422	0.00074	0.000702	0.00086	0.01443	-0.06685	0.00032	0.058768	-0.2	2084

[6] The number of observations may not be satisfactory; however, it represents the most up-to-date data at the time this study was conducted.

TWFIR	422	0.00064	0.000702	0.00077	0.01443	-0.006684	0.00040	0.058676	-0.2	2.83
TWFRR	422	0.00075	0.000703	0.00088	0.01444	-0.006684	0.00040	0.058676	-0.2	2.83
TTTR	422	0.00071	0.000684	0.00060	0.01405	-0.07	0	0.0069784	-0.03	4.84
TENRIR	422	9.63E-05	2.09E-05	2.87E-05	0.00043	-0.000452	6.41E-06	0.003883	5.1	33.25
TERRIR	422	0.00011	2.06E-05	2.99E-05	0.00042	-3.37E-08	3.00E-09	0.003882	5.58	37.1
DPNRTR	422	0.00002	0.000251	-1.1E-05	0.00515	-0.02166	2.03E07	0.025142	0.3	2.93

Variable affixes are defined as: TWFI: Taiwan 50 index; TWFR: Taiwan 50 return index; TTTD: TTT volume; TTTO: TTT open price;

TTTN: TTT number of lot; TWIO: Taiwan stock exchange index open price; NVAR: return of NAV;

TWFIR: return of Taiwan 50 index; TWFRR: return of Taiwan return index; TTTR; return of TTT;

TENRIR: NAV tracking error; TERRIR: reward tracking error; and EPNRIR: premium/discount.

Tracking Error

The two tracking error series, TENRIR and TERRIR, are first tested for mean equality. With a t value of -0.49, the null hypothesis of equal means cannot be rejected, suggesting that the means of the two series are considered to have no significant divergence during the period. The implication is that the management expenses do not represent a significant portion of the tracking error. However, Levene's test for equal variance shows an F statistic of 5.86, which is significant at the 5% level. As a result, the variances of two tracking error series are significantly diverse, implying different structures in volatility, possibly caused by the operations of stock substitution.

As mentioned previously, TENRIR is the tracking error series adjusted and accounting for management fees, stock replacement impact as well as cash dividend accumulation. Based on the return index of the TTT, without deduction of management fees and adjustment of stock replacements, TERRIR will show a greater accumulation value than TENRIR over time. Figure 1 presents this outcome by plotting the accumulations of the two series over time. SUMTE represents the accumulation of TENRIR and SUMD stands for the accruing sum of TERRIR. Two particulars can be identified. First, the path of the accumulation of TERRIR is on top of that of TENRIR. The gap between the two curves confirms the impact of stock replacements and incurred management fees. Second, the accumulation plot shows that during the time periods from 1 to 42 and 247 to 297, coinciding with June and July, two jumps are evident, matching the peak season for dividend distributions from component stocks. In other words, this result is a strong indication that the tracking error is primarily due to the cash dividend to the TTT.

The cumulative difference between SUMTE and SUMD is further examined by a plot, Figure 2, along the time line. The outcome here shows the impact of stock replacements, particularly. The sum of differential tracking errors has accumulated and reached -1.21185% over the sample period. Very interestingly, there are three obvious departures along the downward-sloping trend, as highlighted by circles. These spikes, all negative moves followed by upward climbs, reflect precisely the time points for three of the seven stock replacements.[7] It should be noted that although the impacts of replacements are noticeable, the curve quickly moves back to the main trend, suggesting the short-lived impacts of stock replacements.

Figure 1: Accumulations of Two Tracking Error Series

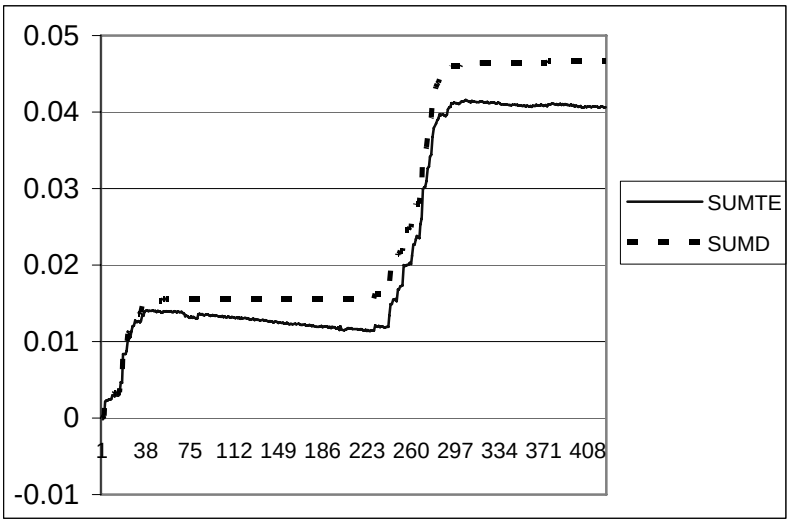
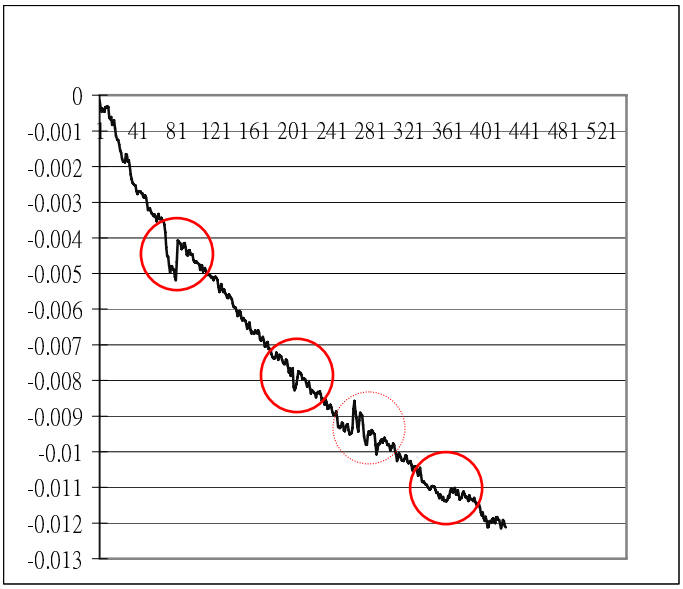


Figure 2: Accumulation of the Differences between Two Tracking Error Series

$\Sigma(TENRIR_t - TERRIR_t)$

[7] Another positive spike is also observed. However, with a 10% significant level, this particular spike is debatable. This impact is shown with a lighter circle to reveal its relatively weak result.



To explore the underlying relationship between TENRIR and TERRIR, the proposed bivariate regression is estimated. As expected, the TERRIR series shows a 1% significant influence on TENRIR, proving that the two tracking error series are highly correlated and the dividend payouts are the principal component of both.[8] Next, the dummy variables are implemented to verify the contribution of stock replacements. Table 2 displays the regression results with and without the inclusion of TERRIR. When the tracking error series is not involved in the model, there are three stock replacements showing highly significant impacts, coinciding with the finding of Figure 2. Nevertheless, after adding TERRIR, the t-statistics of the seven dummy variables become entirely insignificant. In other words, there is no statistical support for their impacts on TENRIR. TERRIR could be seen as the only variable that can be justified as having an impact on the return series. The above regression analysis is re-scrutinized by the stepwise regression which further verifies the previous conclusion. Overall, it can be concluded that the seven stock replacements don't have a statistically significant impact on the tracking error magnitude. If impacts occur, they tend to be short-lived and inconsequential. However, it should be noted that the consistent down-then-up pattern does signal arbitrage potential.

[8] Regression results are available upon request.

Table 2: Regression Results of Stock Replacements

TENRIR = f (D1, D2, D3, D4, D5, D6, D7)		
	Coeff.	t-Value
Constant	0.0002087	1.87*
D1	-0.0000449	-0.36
D2	-0.0001725	-2.32**
D3	-2.51E-06	-0.03
D4	0.0001955	2.59***
D5	9.74E-05	1.31*
D6	-0.0002867	-3.92***
D7	-5.39E-06	-0.06
R-Sq(adj) = 5.5%		

TENRIR = f (TERRIR, D1, D2, D3, D4, D5, D6, D7)		
	Coeff.	t-Value
Constant	-2.94E-05	-1
TERRIR	0.98723	75.15***
D1	1.28E-06	0.04
D2	1.93E-05	0.99
D3	-2.51E-06	-0.13
D4	4.39E-06	0.22
D5	-5.01E-06	-0.26
D6	3.61E-06	0.18
D7	-2.24E-06	-0.09
R-Sq(adj) = 93.5%		

***: 1% significant level; **: 5% significant level; *: 10% significant level.

Premium/Discount

A run test is first applied to probe the randomness aspect of the premium/discount series. The expected number of runs is significantly smaller than the observed number of runs in both of the mean and zero series tests. Thus, the premium/discount series is identified as non-randomly distributed. Following this result, the possible determinants of premium/discount are then explored. As specified earlier, price volatility, arbitrage opportunity, the market volatility of TSEC, and the return of the TSEC are integrated in multivariate modeling. Table 3 displays the empirical results. The price volatility of the TTT and market seem not to be the major factors explaining premium/discount. The significance of the TTT's arbitrage opportunity, on the other hand, cannot be ignored. A substantial price deviation from the NAV signals arbitrage opportunities on the next trading day. As well, the return of the TSEC is identified as having explanatory power over premium/discount movements and magnitudes.

Table 3: Determinants of TTT Discount/Premium

TTT Discount/Premium = f (TTT Price Volatility, TTT Arbitrary Opportunity, Market Volatility, Market Return)	
	t-Value
Constant	0.29
TTT Price Volatility	0.35
TTT Arbitrary Opportunity	2.18**
Taiwan Market Volatility	-1.14
Taiwan Market Return	4.01***

***: 1% significant level **: 5% significant level

TTT Return and Trading Volume

How the TTT return and trading volume are determined is dealt with next. Table 4 indicates that only the TTT arbitrary opportunity and market return influence the TTT return. The TTT's 50 underlying shares are chosen based on the capitalization and each component stock is a leader of its respective industry. Thus, the examined outcome echoes this reality. When the return of the Taiwan Stock Exchange Index increases, the TTT return will follow and move in the same direction. In other words, a high correlation between the TTT return and the TSEC index return can be reaffirmed.

Table 4: Determinants of TTT Return

TTT Return = f (TTT Price Volatility, TTT Arbitrary Opportunity, Market Volatility, Market Return)	
	t-Value
Constant	-1.49
TTT Price Volatility	0.66
TTT Arbitrary Opportunity	-2.92***
Taiwan Market Volatility	1.34
Taiwan Market Return	53.41***

***: 1% significant level

From the regression analysis shown in Table 5, it is clear that the TTT's trading volume is principally affected only by the TTT's price volatility. This result is consistent with the research finding reported by Elton et al. (2002) that the volume of securities is highly correlative with index volatility.

Table 5: Determinants of TTT Trading Volume

TTT Trading Volume = f (TTT Price Volatility, TTT Arbitrary Opportunity, Market Volatility, Market Return)	
	t-Value
Constant	0.86
TTT Price Volatility	5.00***
TTT Arbitrary Opportunity	-0.44
Taiwan Market Volatility	-0.36
Taiwan Market Return	1.04

***: 1% significant level

Discussion and Conclusions

With its ground-breaking role in Taiwan and the enormous global popularity of ETFs for more than ten years, it is imperative to conduct a broad examination of the TTT. The TTT currently ranks as the 7th largest ETF in the world. Such amazing growth can be attributed to the active participation of government funds, national security funds and institutional contributions. However, the holdings are generated by the purchase of baskets of stocks in order to protect the market. Therefore, in order to maintain the stability of the stock market, these major holders will most likely preserve their positions for a rather lengthy period. The resultant turnover rate of the TTT is only 2.83% and in

comparison to the top 20 global ETFs, the turnover rate of the TTT requires further improvement (Elton et al., 2002).

The tracking error of the TTT is mainly constituted by its cash dividends, whose impacts became so obvious in the peak dividend payout season, consistent with the findings of Vardharaj, Fabozzi and Jones (2004) and Lin and Meng (2004). Management expenses also have an impact and are identified as the main factor causing the gap between the two different tracking error series. Furthermore, it is worthwhile to note that the daily tracking error significantly deviates from 0.

Apart from this, it is also important to document the effect on TTT tracking errors of stock replacement operations. From Figure 2, it is evident that there are three apparent departures. Each took place several days surrounding its specific stock replacement. These impacts tend to be negative initially and reverse the movement trend later, signaling a potential arbitrage opportunity. Nevertheless, this arbitrage potential is still quite limited after observing its irregular and intermittent occurrences, 3 out of 7. As well, the duration of the impact is short.

An ETF possesses the features of an actual object redemption system of the primary market and the secondary market. As a result, it will allow an arbitrager to earn a spread based on the difference between the market price and the NAV, forcing the ETF price to move closer to net worth and resolving the serious discount/premium problem that has persisted among closed-end funds. In this research, empirical results based on a run test show that the TTT discount/premium condition does not occur randomly. By applying a multivariate model, the empirical evidence shows that the TTT discount/premium could be attributed to its own volatility and market return. In addition, this condition could also be accounted for by the fact that Taiwan investors have a unique investment habit of over-pursuing prices as the index is booming and over-selling shares as the index is falling. Very often this causes an imbalance in supply and demand, thereby forcing the market price to deviate from the NAV.

The final multivariate results reveal that the return of the TTT is highly correlated with general stock market movements and its arbitrary opportunity. This reflects the view that the TTT is often used as a tool for risk control and short-term trading strategy. However, the trading volume of the TTT is merely affected by its own price volatility. A large price fluctuation within a trading day reflects the opportunity for profitability or the arrival of new information to the market and can effectively stimulate trading interest.

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